AVIATION
AND
AERONAUTICAL ENGINEERING

Photograph of English Military Aeroplanes Ready to be Flown Overseas

AUGUST
15th
1916

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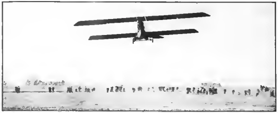

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AUGUST 15, 1916 **AVIATION** AND AERONAUTICAL ENGINEERING VOL. I. NO. 2

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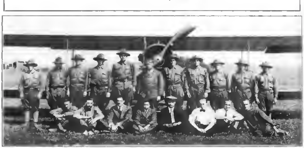

PUPILS AT THE CURTISS AVIATION SCHOOL, BUFFALO, N. Y.

The Harvard Aero Squad, the members of which are standing, is composed of Frederic Stevens Allen of New York, Francis Inman Amory, Jr., of Cambridge, Mass., William Bartlett Bacon of Brookline, Edmond E. Bates of West Medford, Mahlon Phillips Bryan of Brookline, Hamilton Coolidge of Brookline, Donald Dunbar Harries of Cambridge, Harry Hubbard Metcalf of Westborough, Robert Hewins Stiles of Fitchburg, and Joseph R. Torrey, 2d, of Worcester.

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AVIATION
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AERONAUTICAL ENGINEERING

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Vol. I August 15, 1916 No. 2

THERE is perhaps no single factor in the plans for the future development of the aeronautical industry that has so much promise as the willingness of the leaders in the profession to adopt the principle of standardization. Every effort is being made by the various technical groups now guiding the movement to determine also the most efficient materials for aircraft and motors.

The National Advisory Committee for Aeronautics in connection with the Bureau of Standards and the Aeronautic Engine Division of the Society of Automobile Engineers, have started the work of studying important fundamental problems, the results of which are sure to be far reaching. As all of these investigations will be available to the whole industry, every encouragement should be given to those conducting the work.

The valuable service already rendered through the Bureau of Standards, under the direction of Dr. S. W. Stratton, should be remembered. Engineers often fail to realize the vast resources of the Bureau, its extensive equipment and its expert personnel. Its investigations have covered almost the entire line of scientific and engineering activity. In aerodynamics, a report has been furnished on existing types of aeroplane speedometers, steel alloys have been investigated and gasoline engines have been tested. Special studies of sparking plugs and radiators are among the researches now forthcoming. As a clearing house for the manufacturer and the user of aeroplane accessories, the Bureau has an unique opportunity to assist in standardizing the industry. This opportunity it is realizing to the full.

Another influence which will prove a powerful force toward standardization will be the future contract specifications of the government. These will be based largely on the results obtained in the laboratories confirmed by tests made in full flight. As the largest users of all types of aircraft are to be the Army and Navy, their needs will naturally be given the greatest attention.

Abroad, standardization has in certain respects gone much further than in the United States. Through the necessity of war conditions, aeroplanes of a particularly favorable type have been made by manufacturers who have nothing to do with the design. Similar motors have been turned out by factories which were competing before the war. If this principle can be made attractive to our constructors through convincing proof of its advantages, a great step will have been taken toward making possible the production of aircraft on the basis on which automobiles are so successfully manufactured.

Physiological Examinations for Aviators

More and more the physical qualifications of the aviator are being considered. Until recently any one who wanted to fly could learn and become a pilot without feeling in the least the need of a physiological examination. Very little has been known as to the effect of flying on the body and brain. There are now, however, certain fundamental tests through which every prospective aviator should be put before being allowed to fly a valuable machine and run the risk of a sudden physical overstrain when the possibility of this could be determined easily in advance.

Both the Army and Navy require rigid physical examinations. Many men who are entirely incapable of passing these tests are wasting their time and money learning to fly, only to be rejected when trained for these services. The widest publicity should be given to the qualifications necessary for aviators. The physical qualifications laid down for aviation in the United States Navy, which we print on another page of this issue, are of permanent interest and importance.

Here is a field for investigation in which the physician and psychologist can render a service of the greatest value to the country. By eliminating the unfit before they undertake their preliminary training, they will help the schools and the Government as well as the men themselves. Already some work has been done in this direction, but only a beginning has been made.

Technical Cooperation Desired

AVIATION AND AERONAUTICAL ENGINEERING hopes to build on a solid technical foundation. It has already been assured of the contributions of many eminent writers on aeronautics. If, however, its standard of technical interest and usefulness is to be maintained and raised, it must receive the regular support of all technical experts, experienced constructors, designers and investigators in every branch of the industry. Contributions of a technical nature will receive prompt and careful consideration.

Descriptions of new aeroplanes and aeronautical engines which have real technical value will appear regularly. It is hoped that it will be possible to print this information in a more thorough and helpful way than has hitherto been possible. An aeroplane and aeronautical engine information schedule is being prepared which may assist in making these descriptions more useful and valuable.

Photographs of pictorial or technical interest are especially desired.

Aviation and Aerography

By Alexander McAdie

A. Lawrence Rotch Professor of Meteorology, Harvard University

It is nearly fifty years since Lowell wrote, "New occasions teach new duties. Time makes ancient good uncouth." And certainly the truth of the poet's reasoning comes home to us with great force in connection with aviation, the new occasion, and aerography, the new duty. It is apparent that what the hydrographer has done for navigation, and the geographer for exploration the aerographer must do for the domain of the air.

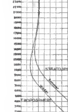

FIG. 1. TEMPERATURE-ALTITUDE GRADIENTS*

It will be well to define in a general way, subject, of course, to later modification, what we mean by the terms used. We would define an aviator as the master of an aeroplane or heavier-than-air machine, one that makes use of the inertia of the air, skimming the air rather than rising by buoyancy.

By aeronaut, we mean the master or pilot of a balloon or combination of balloon and plane, in which hydrogen is used for flotation. These are essentially lighter-than-air machines, even when provided with high-powered propelling engines.

The aerographer may be defined as a student of the structure of the atmosphere, one who charts the physical conditions at all levels. Aerographic charts would then correspond to the well-known pilot charts, the latter for the surface of the water oceans, while the former would deal not alone with the bottom layer, but with all layers up to 15 or 20 kilometers, in the vastly greater ocean of air. Not only tides and eddies, winds and whirls, currents up and down, must be given, but also all port facilities, remembering that in the air any place and every place may be a port of entry.

The American navigator, though but one vessel now flies his flag, where there should be twenty, still takes pride in recalling that the first great study of winds and ocean currents was the work of an American naval officer. Very appropriately the pilot charts bear the words "Founded upon the researches made and the data collected by Lieut. M. F. Maury U. S. Navy." Perhaps then, it need not be wondered at that in the land of Maury, which is also the land of Langley, the Wrights, Chanute and Maxim, there should be published the first volume specifically designed for the use of aviators and aeronauts. I refer to "Charts of the Atmosphere," by Rotch and Palmer, issued in 1911 by John Wiley and Sons.

This volume contains 24 charts, which are essentially a summing up of the work done in exploring the air at Blue Hill Observatory for a period of twenty-five years. Kite work began there in this country as early as 1884 and balloon work in 1904. The cloud work, which interlinks the others, began practically with the establishment of the observatory. The volume gives in some detail values of density, pressure, temperature and air motion from sea level up to 10 or more kilometers.

The aerography of the future, however, must not be limited to one place or country. When the unhappy European conflict shall be ended, perhaps it may be possible by international co-operation to secure and publish a daily map, not like the weather map, showing ground conditions only, and these in some places of doubtful worth, but one giving information at various levels, so that the aviator may prepare his flight accordingly.

Twenty years ago the International Commission for Scientific Aerostation was organized, and but for the war such a digest of data would by this time have been available.

The results of scientific exploration with kites, manned balloons, sounding balloons and pilot balloons are now so extensive that the time is fully ripe for generalization and deduction. Perhaps, however, we shall gain by waiting for the more elaborate data to be obtained from the aeroplane and the aerodrome, to use a word of Langley's, for surely the time is rapidly approaching when fast air route passenger and mail service will be inaugurated.

The logs of aerial flyers will serve just as the logs of the liners have done or the still earlier logs of the sailing vessels of Maury's day, to give a connected story of air disturbance. At present we have only the kite and sounding balloon records, and these, notwithstanding their excellence and the accumulation of data so obtained, are essentially isolated, and if one may use the word momentary. We need continuous records.

It is true that under the auspices of the International Committee for Scientific Aerostation, soundings have been made at many places, but in nearly all instances the observations are made at times of fair weather and near sunset. The last report makes a remarkable showing of the following co-operating observatories: Trappes, Uccle, Soesterberg, Prinsenberg, Pyrton Hill, Limerick, Manchester, Bergen, Christiania, Copenhagen, Pavia, Moncalieri, Milan, Verona, Ferrara, Modena, Florence, Livorno, Vigna di Valle, Monte Cassino, Mileto, Zürich, Friedrichshafen, Stuttgart, Strassburg, Aachen, Cologne, Hamburg, Lindenberg, Munich, Vienna, Pola, Trieste, Pavlovsk, Nijni-Oltchedaeff, Sebastopol, Tiflis, Ekaterinburg, Vladivostok, Giza, Batavia, Blue Hill and Mount Weather.

Soundings have been also made at sea by the *Scotia*, sent out by the British Board of Trade as an ice patrol and by our own Coast Guard cutters, *Seneca* and *Tampa*.

One might say what more is needed? The answer is as somewhat foreshadowed above. We need exactly what Maury obtained from his great collection of logs of merchantmen, data that taken individually are fragmentary, but considered together piece out the whole story and enable one without great effort to chart the winds and pressure gradients over wide areas. Thus the logs of aeroplanes in service, carrying, as they undoubtedly will, recording instruments for tempera-

* The temperatures are given in degrees absolute. On this scale 273 degrees is the temperature of melting ice, the familiar 0 degree Centigrade or 32 degrees Fahrenheit. Absolute degrees are practically Centigrade readings plus 273 degrees.

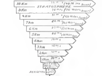

FIG. 2. INCREASE OF VELOCITY WITH ELEVATION

FIG. 3. SEA-BREEZE STRUCTURE

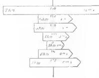

FIG. 4. SEA-TURN STRUCTURE

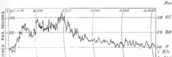

FIG. 5. GUSTINESS (MODIFIED FROM "CHARTS OF THE WIND")

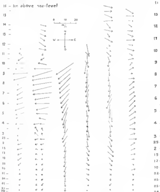

FIG. 6. THE WINDS OVER VIENNA FROM APRIL 26 TO MAY 1, 1915. THE LOWER DIAGRAM SHOWS THE PRESSURE ON THE GROUND

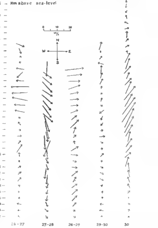

FIG. 7. WIND CHANGES WITHIN A PERIOD OF 24 HOURS

Fig. 8. Photograph of the Clouds Preceding Rain Four Hours

ture, pressure, wind velocity and direction, will soon furnish information, probably of more direct value than the fragmentary results of observatory soundings by balloons.

There is, of course, no reason why the regular records should not be supplemented from time to time by additional observations of an experimental nature, perhaps with pilot balloons and other devices, although the rapid movement of an aeroplane must invalidate most observational values.

Air explorers have given us much in the long period of their work, 132 years, for we may in all justice say that air exploration began with the ascent of Dr John Jeffries in 1783, and his successful crossing of the English Channel in January 1784 In the earlier ascent he obtained good readings of pressure, temperature and humidity, and brought down samples of the air for chemical analysis from various levels up to and exceeding 2 kilometers So far as I can ascertain, this is the first log to which the aerographer can refer The instruments then used are in good condition in Boston to-day

Two other remarkable men, personal friends and co-laborers, may be referred to here as pioneer aerographers, Leon Teisserenc de Bort of Paris and A Lawrence Rotch of Boston. Their joint work contributed largely to the discovery of the existence of the stratosphere, or region above which the temperature no longer falls, but may even rise Some meteorologists refer to this as the isothermal column, but the name suggested by de Bort stratosphere, is far more appropriate, and is now in wide-spread use.

In a general way, the stratosphere begins in these latitudes near the 10 kilometer level Referring to Fig 1 a temperature-altitude gradient chart an aviator gets a good idea of temperatures to be expected at different elevations The higher regions are, of course, beyond consideration for practical purposes. It may not be without interest to give a short table of the extreme elevations reached by various means

By kite 7044 meters, at Mount Weather Va
By aeroplane 7404 meters Hawker in April 1916
By manned balloon 10,500 meters Berson July 1901
By sounding balloon 37,000 meters, at Pavia Italy
By pilot balloon height determined by theodolites 39,000 meters, at [illegible]

Most aeroplane work will be done below the 4000 meter level and in the winter months below the 2000 meter level While temperature is perhaps the most important factor in aviation, the extreme and average wind velocities and durations and directions will need consideration By reference to Fig 1, a wind-altitude gradient chart, one gets the average increase of velocity in meters per second per thousand meters rise. The average velocity at a height of 4000 meters is 19m/s

In general, the winds are from the west, and there is a steady increase with elevation. The velocity falls off decidedly in the stratosphere While the general conditions are given in Fig 2, there are certain well known and recognizable conditions, such as the sea breeze and the sea-turn, which are of interest to aviators

In Fig 3, showing the structure during sea-breeze, the directions are given in degrees in the center of the arrow and the velocities near the arrow-head It is thus plain that the sea-breeze is a shallow draft, and in fact is not appreciable above 2000 meters For more detailed information the reader is referred to "The Winds of Boston."

Fig 4 illustrates the structure during sea-turn, showing what conditions may normally be expected in advance of a storm from the southwest.

Of course, in such an aerographic chart as has been outlined in this paper, there would be given mean summer and winter temperatures, winds and velocities for each 200 meter level and the departures from these for various hours and various types of circulation

Conditions of gustiness or variability in both velocity and direction will need the fullest exposition, for this does affect stability Fig 5 illustrates the type of wind structure which might well cause pitching and yawing, and it is problematical whether the character of the flight would be at all similar to one in a steady or uniformly varying structure

Flight at low altitudes is probably more dangerous than at high levels, and it would be of the utmost value in an aerographic chart to locate zones of maximum gustiness Incidentally, we may remark that the ordinary form of cup anemometer is poorly adapted to give records of the rotary motions of air in all planes. What is wanted is a dynamometer rather than a speedometer

The writer has elsewhere (*The Geographical Review*, April, 1916) given certain photographs of models showing the structure of the atmosphere on certain dates, based largely upon the models used by Cave in his well-known "Structure of the Atmosphere in Clear Weather" It is not necessary to refer further to them here or to the recent work of Sir Napier Shaw and certain recent views of Dines and others pointing out inconsistencies in the older meteorology, especially in connection with the origin of cyclones and anticyclones and the role played by convection in their formation

French, American, British, Italian German, Austrian and Dutch meteorologists alike contribute their portion to the solution of the great problem of air flow at all reachable levels.

An interesting example of such work is a description of the pilot balloon ascents made in Vienna, April 26 to May 1, 1915, given by Dietzius in the *Meteorologische Zeitschrift* December, 1915, from which Figs. 6 and 7 are taken The diagrams are self-explanatory

The aerographic chart would not be complete without full discussion of the distribution of the water vapor at all levels and the various amounts and frequencies of precipitation in all forms rain, snow, hail and frost and cloudiness. There is always some danger from thunder-storms, and any marked rotary storm from the desert sand-storm to the tornado of the great waterways

The photograph reproduced in Fig 8 illustrates cloud formation at Blue Hill in advance of heavy rain Fig. 9 illustrates the surface pressure and wind direction and velocity during a winter month—to illustrate number of marked storms and duration

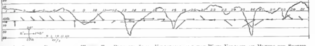

Fig 9 Surface Pressure and Wind The Pressure Is in Kilograms, and the Wind Velocity in Meters per Second

An English Photograph of Great Interest

The picture on the cover of the issue is of particular technical interest to American aeroplane designers, in view of the fact that this is believed to be the first authentic photograph of British military aeroplanes of service type released by the Official Press Bureau Machines of either tractor or pusher type are evidently approved and the uniform equipment with four bladed propellers is significant

Recent experience with high power two-bladed propellers in this country has led some to maintain that the wooden two-bladed propeller had reached its limit and to insist on a steel propeller It may be that pending the development of a steel blade—and there is none in sight—the solution of the propeller problem is to be sought in the four-blade type, which obviously reduces the thrust per blade and hence the bending moment at the root of each blade

Another lesson is to be drawn from the photograph by observing that the wings of each machine are swept upward, making the dihedral angle recommended by writers on dynamical stability The lateral stability of the Royal Aircraft Factory type has been repeatedly demonstrated

In an article in our last issue Dr Hunsaker showed that the so-called "directional stability" is intimately associated with lateral stability, and to avoid what he called a "Dutch roll" in dihedral angle aeroplanes he pointed to the necessity for adequate vertical surface aft In this connection, note in the photograph the uniform employment of a fixed fin forward of the rudder The proper size fin has evidently been a matter of concern to the British designers, as is indicated by the larger fin for the two powerful tractors identified in the picture by the three-wheel landing gear

The matter of landing gears shows a lack of uniformity which should be of interest to those who contend for "standardization at any cost"

The third wheel, to prevent pitching over on the nose, is not new, but its greatest advantage has not been emphasized. This is considered to be the facility for the employment of radius rods, which greatly increase the ability of the gear to withstand "side swipe" in landing In the first machine on the right note the fine lines of the body and the very shallow after-body.

The Steel Construction of Aeroplanes

By Grover C. Loening, B.Sc., A.M., C.E.
Vice-President of the Sturtevant Aeroplane Company

The Sturtevant Aeroplane Company has recently developed a new type of steel construction for aeroplanes, tests of which have shown that it has many advantages in reliability, lightness and strength that cannot be obtained in wood. For the fuselages, rudders and tail surface, methods of using steel have been devised which are remarkably successful.

The construction of aeroplanes has usually involved the use of wooden members fastened by steel fittings, which, due to the greater stresses involved in larger aeroplanes, have gradually become more and more bulky and complicated. A study of the construction of large-sized aeroplanes at the present time reveals that the weight and cost of manufacture of these metal fittings has become a much larger item than was formerly the case.

A departure from the usual wooden construction of aeroplanes that has been used in a few instances is the application of steel tubing not only in the bracing members and struts, but also in the wing spars and in the fuselage construction. A study of this development has shown definitely that steel tubing construction is heavier than the customary wooden construction for the same strength. In addition, it has been found that the joints are difficult to make in steel tubing construction, requiring a great deal of welding and brazing into suitable sleeves, with the general result that the joint is heavier and not as reliable as desired because of the indeterminate nature of a welded or brazed joint.

It has been clear, however, for some time that steel construction was desirable for aeroplanes not only in making them more mechanical, more durable, fireproof and more weather resisting, but from the fact that steel as a structural material, has in all branches of engineering been found more reliable and better adapted to manufacturing in quantity.

The problem confronting the Sturtevant Aeroplane Company, therefore, was to apply the principles of steel construction that had been developed with such success in structural shipbuilding, engineering, automobile and machine tool work. It was apparent at the outset that what had been done in applying steel to the construction of aeroplanes required considerable development and modification in order not to increase the weight of the machines and to simplify the fitting of members to each other.

Entirely on its own initiative, therefore, this company decided to use in aeroplane construction structural steel sections of angles, channels, I beams and the like, with riveted and pinned joints exactly as is the practice in the most refined civil engineering of structures. The only data available to guide this new development was what had previously been obtained by the author in his experiments with this type of construction in 1912 and 1913.

Several kinds of metal working tools, metal bending machines, angle and channel benders, corner breaks and powerful presses were available for this work at the Hyde Park plant of B. F. Sturtevant Co. After experimenting with the size and strength of various members and with different types of riveted joints and pin connected joints, designs were drawn up for the fuselage of the Sturtevant tractors, consisting of longerons of steel angles and struts of steel channels, with a few special rolled sections peculiarly well adapted to the work.

The computations for the size of all these members were made following the best engineering practice, on their bending moments, moments of inertia, reliability of fixing, etc. After the sections had been established by calculations, exhaustive tests were made on the strength of the various members at the Massachusetts Institute of Technology.

The values of strengths thus determined checked remarkably closely with the computed strength of the members, giving a most striking illustration of the accuracy with which steel members can be designed. The stresses in the fuselage induced by the air loads, tail skid loads and whip of the tail being determined, the fuselage was constructed with suitable safety factors.

In the flying tests of the various Sturtevant steel aeroplanes conducted recently and in several tests of severe landings that have been made, it has been demonstrated that both this design and construction fulfill in every way the functions called for.

In addition to the construction of the fuselages themselves entirely of steel, the engine beds of these aeroplanes are also made of steel and have definitely demonstrated a similar reliability and correctness of design.

Furthermore it was decided to construct surface frames of structural steel, and as a first step towards this end the flaps of the elevator were made of steel channels and angles. After some preliminary experimenting, a method of constructing these simply was devised and upon completion it was found that these flaps were actually lighter, more rigid and much more serviceable than those ordinarily made of wood or of steel tubing.

This was followed by making the rudder and wing flaps also of steel, and lately the Sturtevant company has extended this to the construction of the wing itself entirely of structural steel sections. The steel wing construction has received severe tests and thorough demonstration.

An account having thus been given of the general nature of the development of this new type of construction, the various features may be taken up in greater detail. To simplify the consideration of this matter as much as possible, two instances in which this construction is used will be taken up.

Fuselage Construction

The framework of the fuselage of Sturtevant Model A Tractor battleplane actually weighs 165 pounds, inclusive of engine bed, which is entirely of steel and pin connected to the main frame, and also inclusive of all the bracing in the fuselage.* The loads that it is necessary for the fuselage to carry are the whip of the tail on landing, the positive and negative air loads and the tail skid load.

It is customary in designing to compute the value of all these loads and to design the frame to withstand them all with a factor of safety of at least 8 in the case of the air loads, and in the case of the tail skid load with a factor of safety of at least 4. This latter figure has come to be considered quite strong enough for the tail-skid loads as the condition under which the maximum load is imposed is when the machine is slowing down on landing with the motor stopped—it being obvious that, due to its height, any thrust on the propeller greatly reduces this load.

The tail skid load of this machine lies between 350 and 400 pounds, due to the position of the landing gear wheels at the front, and varies with the load carried on the machine. On the smaller sized aeroplanes this load is usually between 50 and 150 pounds, so that it is apparent that the function of the tail skid and the strength required of the fuselage have

* It is to be noted that this refers to a very large aeroplane of the battleplane class, and on the smaller Sturtevant reconnaissance type the fuselage is much lighter.

FIG. 1. STEEL CONSTRUCTION IN FUSELAGE

become very much greater in this larger type of aeroplane. This load, as a matter of fact, has become the governing feature in the strength of the fuselage and induces stresses far greater than the air loads.

From theoretical considerations and practical experience of such construction, the design of a wooden fuselage, with metal fittings, using ash in order to obtain the required tension strength, on aeroplanes approaching this size, indicates a weight of over 200 pounds, of which the fittings and wires alone would weigh about 60 pounds.

The accompanying photographs indicate the manner in which the longerons of the fuselage and the channel sections, struts and cross braces are fastened to each other directly without the addition of anything at all in the way of extra fittings, the members being placed simply one on top of the other and rivetted with the required number of rivets to develop the strength required of the member. This feature alone has in this fuselage saved in one stroke about 60 pounds in weight. In addition the time required for the manufacture and assembling of metal fittings ordinarily necessary at each joint is entirely eliminated, and it is possible to assemble the frame in a very short time.

It is, of course, most reasonable to suppose that this steel construction as it develops will involve many minor changes in the method of fastening and details.

In the Model A Tractor, taken as an example, the entire fuselage of which is constructed in this manner, actual flying and landing tests have been conducted frequently since the first week in December, 1915. Severe landing and taxi-ing over rough ground have demonstrated the reliability and correctness of this construction, which has withstood all proper stresses induced in it without the least sign of being in any way inadequate. It is maintained that this in itself is a remarkable indication of the value of this construction in that the design of frame has required no alteration and actually has revealed not the slightest sign of weakness under severe tests.

The process of manufacture of these parts is exceedingly simple, in that the cold rolled steel delivered by the mills in the exact widths necessary for the different members is received at the factory, marked and cut to the lengths of the members. These are lightened in a few minutes by having the lightening holes punched out in a gang punch. The members are then bent up or pressed in a die to the angle or channel shape desired, the member then taking its completed form and is ready for attachment to neighboring members without the necessity of any extra fitting having to be made.

In the future it may be possible to purchase channels and angles of the sizes required from steel manufacturers, or, as planned by this company for quantity production of aeroplanes, it would be necessary merely to have them made in the large metal forming presses, with dies for blanking out and pressing up the members in one operation.

It is clear, therefore, that for quantity production where a die would be used the manufacture of a member of the fuselage, with all its lightening holes and rivet holes complete in itself and with no extra fittings required, could be made in a

few seconds producing a great saving of both time and expense

When this is compared to the former process of first, sawing up the lumber, then cutting it to size, then trimming it, then finishing it, and after that being compelled to make an additional fitting, expensive, complicated and heavy to fasten this member to its neighbor, it becomes apparent that the manufacturing advantages of using this pressed steel construction is actually of the very greatest fundamental importance to the industry, exactly as it has proven to be in almost every other industry

pressed out in great quantities by suitable dies and fastened to structural steel spars.

Surface construction of this kind actually shows that it has weight of less than one-half pound per square foot This is very much less than is obtainable with the ordinary wood type of construction for the same strength, and, in addition thereto, the steel construction gives an excellent rigidity and mechanical appearance to the surface which is most pleasing.

This method of aeroplane surface construction has also been demonstrated structurally and from a flying standpoint on the

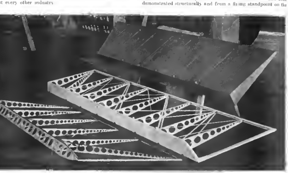

Fig. 2. Steel Construction in Wing and Elevator Surfaces

The disadvantage of steel construction, often cited, of crystallization, etc., is met by using special pin connected joints with shock absorbing washers to take up the vibration of the engine bed, and by using a vanadium steel, which is considered proof against crystallization

In considering this it must be borne in mind that the metal fittings on wooden fuselages are also subject to crystallization and the absorption of vibrations by the wood is not any more advantageous than the absorption of vibrations by proper pin connected joints in the correct steel design

Rudder and Elevator Construction

Another instance of the use of steel construction is in the framework of the surfaces themselves as used and demonstrated in the aeroplanes above referred to, the rudders, elevator surface and aileron surfaces of which are constructed of steel frames covered with linen.

The stresses on members of this kind are not clearly definable and the suitability of this construction has required considerable experimenting This, however, has finally resulted in the adoption of the type of construction here illustrated Briefly described, this construction consists in forming the ribs of a steel channel section with flanged lightening holes readily

Sturtevant aeroplanes, and a great deal of the flying excellence of these machines may be attributed to the strength, rigidity and general mechanical excellence of the control surfaces obtained by this new type of steel construction

Wing Construction

The success and ease of manufacture of this steel construction of rudder and flap surfaces has led to the investigation of the possibility of constructing the aeroplane wings by a similar system Experiments were, therefore, conducted on various methods and sizes of ribs, and finally an entire wing section of this construction was made and covered. This section was fixed on a span of 8 feet and tested in the presence of several witnesses, with sand bag loading, in order to determine the suitability of the ribs and spar construction to withstand the air loads The frame was actually made of exactly the same weight as a wooden wing to withstand the same load, or 300 pounds distributed on the 60 square feet of wing section, the frame being designed to have a safety factor of 8.

Numerous sand bags were distributed on the wing according to the usual method of testing On top of this were superimposed a great number of very heavy lumber boards, and finally, in order to obtain a breaking load, it was necessary for

three of the witnesses present to stand on top of this load

When there had been imposed a total of 2550 pounds, the wings slowly began to fail by the bending of both of the spars exactly at the point at which the bending moment diagram indicated the least strength factor The breaking load of 2550 pounds, where the wing section was designed to carry 300 pounds, indicated a safety factor of over 8 This entire test is in itself an unusually clear instance of the accuracy with which steel construction may be designed

Summary

The fuselage construction and the surface construction for rudders, elevators, etc., have proven to be highly satisfactory and have been adopted as standard after very careful study by the Sturtevant company

The ease with which rivetted or pinned joints can be made between angles and channels and the excellent fit of the different members to each other without any extra fittings is nothing short of a revelation in aeroplane construction Military aeroplanes that can be left out of doors and naval aeroplanes that can ship big seas without "spoiling" can be attained by the use of this new type of steel construction

While a difficulty is foreseen in adapting wood to the construction of huge aeroplanes of the battleplane class, with steel it is readily possible and even advantageous to grow to larger sizes. Though small in size at present, the channels, angles and I-beams with rivetted joints have thus been introduced into the aeroplane structure and pin connected joints, gusset plates and the lightening of webs and flanges used in the most approved maner have enabled the aeroplane fuselages, wing frames, etc., to be built like miniature bridges, a resemblance that is as pleasing as it is striking.

General Specifications for Aeronautic Instruments

"General Specifications Covering Aeronautic Instruments" is the title of Report No. 8 that has just been issued by the National Advisory Committee for Aeronautics, by whose request it is reprinted here

For the information of those concerned with the use of production of instruments used in the navigation and operation of aircraft the following general list and specifications have been prepared with a view to indicating the lines on which development is required, and the restrictions and difficulties to be overcome in the design and construction of aeronautical instruments

All indicating instruments required in the navigation of aircraft should be as compact, rugged, and light as is consistent with accuracy, reliability and durability, and with ease of reading Such instruments must be free from the influence of the following disturbing effects, excepting, of course, those effects on which they depend for their operation, viz. vibration, change of altitude and change of temperature

Barometer or Altimeter—Barometers or altimeters must be sensitive and of open scale, and the lag in their operation should be the absolute minimum obtainable When operating in a fog it is essential that the distance above the surface should be known within very close limits. Such instruments, of course, are dependent on barometric pressure and on variations of barometric pressure from the time of the start of a flight until the completion of a flight, which cannot be provided for, but aside from this error their indications should be substantially accurate once they are adjusted at the point of departure It is, therefore, necessary that the scale should be of equal divisions, as otherwise a change of zero to meet change of barometric height will introduce an error Their location on the aeroplane must be carefully chosen so that their indications will not be influenced by the velocity pressures in flight

Compass—Compasses should have as high a directive force as is consistent with restricted dimensions Provision should also be made in the compass mounting for compensation for the presence of magnetic material in the construction of the aeroplane, particularly compensation for heeling and dipping errors. In order that the directive force shall not be abnormally reduced by such compensation, it is, of course, desirable that the structure should avoid the use of magnetic materials in moving parts near the compass location, such as the control columns, shafts, and leads.

Air Speed Meter—An air speed meter should indicate reliably the speed through the air, and should be free from the effects of accelerations, as when the machine is banking strongly in a turn the effect of gravitation is augmented by the presence of the centrifugal force. As the sustaining power of an aeroplane is dependent upon the density of the atmosphere it is considered that air speed meters which are dependent on the pressure due to velocity will be a safer form of indicator than a true anemometer type

It is essential that the indicators shall be particularly sensitive and have an open scale reading at velocities approaching a stalling speed, which is the lower limit of safe flying speed. It is also necessary that they should indicate high speeds accurately, in order that excessive speed may be avoided when gliding Excessive speed in gliding involves danger when a machine is brought up too sharply, as the combination of high speed and the maximum lift factor may readily stress the machine beyond safe limits Also, when flying at high speed the angles of attack are small, and there is danger of the aeroplane entering a critical condition in which the flow of air may develop radical changes of state, and consequently great changes in the lifting power available. Air speed meters should be capable of calibration immediately prior to a flight Air speed meters of the Pitot type dependant on a fluid are subject to gravitational errors when banking. They are also subject to error due to heeling or diving Unless the leads from the Pitot tube to the indicating instruments are sufficiently large, there is also danger of a serious lag in indications.

Inclinometer.—Inclinometers of the pendulum or spirit-level type are inaccurate in the presence of accelerations and are only useful as a general check as to the attitude of the machine when flying in a fog. It is very desirable that an indicator free from these defects should be developed. A gyroscopic base line is considered desirable not only for purposes of indicating inclination but as affording a base line for sighting and for the use of instruments of navigation.

Drift Meter.—Drift meters are of two types—one designed for the purpose of indicating leeway over the surface for use in connection with navigation, and the other more properly termed "side slip indicator" for the purpose of indicating whether or not the machine is flying square to the wind. The latter designation is considered preferable for indicating the attitude of the machine For navigating over the ground the course is readily determined by ascertaining the apparent motion of objects on the surface, and the same method is available for navigation over the water, provided there is a definite object on which to sight. One type of drift meter indicates by the streaking of waves across the objective glass of the instrument as apparent drift, but as the particles of the waves themselves which indicate this streaking have a velocity of their own, such indications are subject to error If the surface wind direction or velocity were known, correction might be made but when flying at an altitude of several thousand feet it is very likely that the aeroplane itself may be in an entirely different current of air than that present at the surface In addition to this, tidal currents may also affect the velocity of the water particles. Two forms of side slip indicators exist, the simplest form being that of the well-known string or pennant, but the latter cannot be used satisfactorily in the wake of a tractor propeller. The other type consists of a very sensitive pendulum which indicates whether or not lateral accelerations are present, as will be the case for a machine which is not properly balanced laterally, but such an instrument is subject to the defect that if the machine is side slipping laterally at a constant speed, lateral acceleration is no longer present. It can only be depended on to indicate initial disturbances.

Tachometer.—Tachometers should be absolute in their indications, and if electrical should not be subject to disturbances in the conductivity of circuits from any cause, or to deterioration of magnetism of a permanent magnet.

Oil Gauge.—Oil gauges must definitely indicate the amount of oil present in the crank case

Oil-Pressure Gauge.—Oil-pressure gauges must accurately indicate the pressure in the oil system and should also indicate that the flow of oil is undisturbed.

Gasoline Gauge.—Gasoline gauges should indicate the amount of gasoline available in the main tanks, and should not depend on the visibility of gasoline in a glass tube, as, due to the transparency of gasoline, a full tank and an empty tank would give the same indications. Mechanical indicators are considered preferable.

Gasoline-Flow Indicator.—Gasoline-flow indicators should depend on mechanical means of indicating that the gasoline is being supplied from the main tanks to the service tanks.

Distance Indicator.—For navigation at sea or over unknown country, it is desirable that a record of distance flown through the air should be available. If it were not for the fact that the slip of the propeller depends largely on the load of the machine, and whether or not the machine is climbing or gliding, an engine counter would serve this purpose, but it is considered preferable to have a counter or recorder actuated by an anemometer for this purpose In either case, actual distances over the surface will require correction for the wind velocity and direction.

Barograph.—Barographs are subject to the same general specifications as altimeters.

Angle of Attack Indicator.—An angle of attack indicator should be dead beat, free from the effects of gravitation, and accurately respond to and indicate any change of the direction of flow of air to the supporting surfaces It should be light, rugged and its indication should be clearly legible to the pilot. It should be designed for attachment in advance of the wings on a tractor biplane and clear of the influence of the propeller or the fuselage

Radiator Temperature Indicator.—A radiator temperature indicator should be readily inserted in the top of the radiator and should clearly indicate the best operating temperatures. The thermometer should conform to best practice, and the entire instrument be sufficiently rugged to withstand reasonable vibration and shock

Gasoline Feed System Pressure Indicator.—Where the gasoline feed is not gravitational, the indications of the pressure available must be accurate The gasoline feed system pressure indicator must not be affected by vibration or change of temperature It must have a good scale and a dead-beat action

Sextant.—Sextants should be as light and small as possible commensurate with proper accuracy A sextant for measuring the altitude of a heavenly body above a horizontal plane without the use of the sea horizon or an artificial horizon would be most desirable

Aeroplane Director.—An aeroplane director for the mechanical solution of the course and distance made good, based on the course and speed of the aeroplane and the force and direction of the wind, is a desirable development.

The Testing of Barometers

In Circular No 46, recently issued by the Bureau of Standards, much useful general information is given on mercurial barometers, primary standard high altitude and common, and on aneroid barometers. The precautions necessary in the use of barometers are classified and briefly discussed with reference to nature of the measurements in question, the possible defects in the barometer, the unavoidable sources of error in the instrument, and in the corrections which theoretically should be applied even though the instrument be mechanically perfect

A very clear distinction is made between barometers which are used for absolute measurements in which sensitiveness of the indications is of very small moment compared with freedom from elastic lag and instruments such as the aviators' barograph, in which indications should not depend on the speed at which pressure is changed Barographs failing to satisfy this condition are apparently not likely to receive the bureau's certificate.

To those interested in barometric instruments the circular provides also a useful guide to the making of inquiries, and gives information as to purely nominal fees which are charged for testing

Aeronautic Courses at the University of Illinois

With the commencement of the autumn session, courses in aeronautics will be given at the College of Mechanical Engineering, University of Illinois E. N. Fales, a graduate of the Massachusetts Institute of Technology, has been appointed assistant professor The courses, which will be of a general nature, will be restricted to senior students of the mechanical engineering class

Mr Fales experimented in the first wind tunnel at the M. I. T., has kept in touch with all aspects of aeronautics, and is now leaving the engineering department of the Curtiss Company, where among other duties he has been in charge of the students' department

Course in Aerodynamics and Aeroplane Design

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PART 1—SECTION 2

Elements of Aerodynamical Theory

LIQUID, FLUID, AND PERFECT FLUID

Both liquids and fluids may be defined as substances which flow or are capable of flowing. A liquid is incompressible and therefore of constant density, a fluid is compressible and of varying density. Thus water is commonly spoken of as a liquid, air as a fluid, yet the hard and fast distinction is unfair, since water itself is slightly compressible

In the transportation speeds employed in aeronautics, the variations in pressure of the air, and the consequent variations in density are so slight, that the air may also be regarded as incompressible Thus for a dirigible at a speed of 100 miles per hour the increase in pressure at the nose is only about one per cent It is only at the tips of fast moving propeller blades that the compressibility of air assumes any importance

The motion of fluids is so complex that no complete mathematical theory has yet been evolved for it In hydrodynamics the mathematicians have stipulated a perfect fluid possessing no viscosity. In such a fluid all bodies may move without encountering resistance Although the conception of a perfect fluid may seem of no practical importance, yet hydrodynamical theory serves as a guide in the theory of aeronautics and we shall have to make occasional reference to this idea

DENSITY OF AIR

In setting forth data from the laboratories the air will be assumed as having a temperature of 15° C and a density of .07608 lbs per cubic foot at sea level

VARIATION OF DENSITY OF AIR WITH HEIGHT

Height (ft.)	*Density (lbs per cu. ft.)*
0	.0761
500	.0748
1,000	.0734
2,000	.0707
5,000	.0632
10,000	.0523
20,000	.0357

PRINCIPLE OF RELATIVE MOTION

We shall assume throughout without further reference that the same resistances will be brought into action whether a body is moving through a fluid or a fluid is streaming past a body, provided the relative motion is the same

This is an idea which often presents difficulties and is very difficult of theoretical demonstration, yet it is merely a matter of common sense In *La Technique Aeronautique* of May 15th, 1913, M. Lecornu has given a very sound discussion of this point We will venture a rough illustration Imagine a boat propelled through a river at rest at a speed of 5 miles per hour The oars will exert a certain force of propulsion. Now if the river has a contrary current of 5 miles an hour, the boat will remain at rest relative to the banks, yet exactly the same force will be exercised by the oarsman There is really nothing more to be grasped underlying the principle of relative motion

Bernoulli's Theorem for Fluid Motion

In the steady flow of a fluid the current at any point is always in the same direction and magnitude and may be represented by a series of stream lines, or by tubes of flow

The energy of a fluid consists of three parts: (1) The potential energy, or the energy due to its position of height through which it may fall, (2) The pressure energy, (3) The kinetic energy due to its motion, neglecting the effects of viscosity or friction Bernoulli's theorem states that along any stream line, the sum of these energies is a constant, and if

g = acceleration due to gravity
h = height
p = pressure
V = velocity
ρ = density*

$$h + \frac{p}{\rho} + \frac{V^2}{2g} = \text{constant}$$

In considering air flow in aeronautics where we deal with a fluid ocean of immense depth, the variations in height are negligible, and the theorem becomes:—

$$\frac{p}{\rho} + \frac{V^2}{2g} = \text{constant}$$

The theorem is of fundamental importance in aeronautics, its proof will be found in any text-book on hydrostatics.

This equation may also be written in the following useful form, by multiplying both sides of the equation by ρ

$$p + \frac{\rho V^2}{2g} = \text{constant}$$

Total Energy of a Fluid Applied to the Theory of the Pitot Tube

The Pilot Tube, so frequently employed in Aeronautics to measure the speed of a machine in actual flight, furnishes an excellent illustration of the principles just set forth. In Fig 1 is given a diagram of such a tube.

Its main function is to measure the velocity of flow for a steady irrotational flow of air, and it is unsuitable for measuring the velocity of turbulent flow, such as that occurring in the vicinity of a fan to give an example

In practice the Pitot tube is finely rounded so as to give the least possible disturbance to the air flow It consists of two concentric tubes The inner one is open to the wind, the outer tube is closed to the wind and is connected to the inner tube by a series of fine holes The tubes are connected to the two arms of a pressure gauge as shown in the figure, and the gauge measures the difference in pressure between them

The inner tube, open to the wind, brings the air impinging

* ρ (*Rho*) is used for Density to prevent confusion with *D* for Drag and to conform with standard usage

on it to rest, and the pressure in it is therefore a measure of both the static pressure in the stream and of the kinetic energy head of the stream. If p is the static pressure of the stream, V the velocity, the total pressure will be given by

$$p + \frac{\rho V^2}{2g}$$

The outer tube, on the other hand, being closed to the wind, will, if the holes are small enough to prevent velocity having

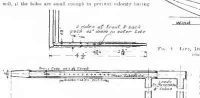


Fig 1 Pitot Tube

any effect on its pressure, read the static pressure of the air flow.

Hence the difference in pressures read on gauge will be

$$\frac{\rho V^2}{2g}$$

and will therefore be a measure of the velocity

We shall discuss the methods employed in connection with the Pitot gauge more fully when dealing with Laboratory methods, but may state now the results of recent experiments as summarized by Dr. J. C. Hunsaker

1 The precision is one-tenth of one per cent

2 The open tube correctly transmits the total pressure regardless of size or shape

3 The nose of the combination tube must be of easy form

4 The static openings should be clean holes from 0.01 to 0.04 inches diameter

5 Static openings should be well back from the nose of the instrument on a polished cylindrical portion of the tube

6 Static openings may be from 4 to 24 in number arranged in an arbitrary manner.

7 The tube should be pointed into the wind, but an error of two degrees in alignment will cause less than 1 per cent error on velocity measurements

Definition of Angle of Incidence, Resultant Pressure, Lift, Drag and Center of Pressure in a Plane or Cambered Wing Section

Whether for a plane or a curved wing section, the angle of incidence is defined as the angle i expressed in degrees, between the relative wind and a line in the supporting surface, termed the chord. In the case of the flat plate, this line coincides with the face of the plate and is physically justifiable since when the face of the plate coincids with the relative wind, there is no sustaining force or lift on the plate

Fig 2. Lift, Drag, Angle of Incidence, and Chord for Flat Plate.

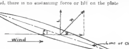


Fig. 3 Lift, Drag, Line of Chord, Angle of Incidence for Double Cambered Section

In the case of cambered surfaces, the position of the chord has been fixed by conventional usage, and is best illustrated by the diagrams in Figs. 2, 3 and 4. With cambered surfaces, when the conventional chord coincides with the relative wind there is lift as a rule, although the position of no lift may be only a degree or so removed

Owing to the relative motion of the air the wing experiences a resultant pressure which we will designate as R. This resultant is very nearly normal to the face of a flat plate, but it is quite wrong to state that it is exactly at right angles to this face. The resultant force R may be generally resolved into two components, one at right angles to the relative wind, which is termed Resistance or Drag (D). Drag will be used instead of the term drift, which unfortunately is capable of misinterpretation The component at right angles to the relative wind, L, may act upwards, giving *Positive Lift* or downwards giving *Negative Lift*, depending on the position of the surface relative to the wind

Fig. 4 Lift Drag, Angle of Incidence and Chord for Cambered Surface.

The lift measures the sustaining power, the drag the resistance to forward motion The tangent of the angle between the R and D gives the ratio L/D, lift over drag The greater the value of L/D the greater is the path efficiency of the supporting surface

The center of pressure will be arbitrarily defined as the point of application of the resultant force R on the plane of the wing chord This is by no means a rigid definition

Definition of Lift and Drag Coefficients

We shall employ throughout the following notation

Lift $= L = K_y AV^2$. Resistance or Drag $= D = K_x AV^2$.

Where L and D are in pounds, A = area in square feet of one surface projected on the line of chord, and V = velocity in feet per second, K_y and K_x will represent forces for unit areas and unit velocity We shall see later the justification for these expressions.

Position of Center of Pressure or Resultant Vector of Forces

It has become customary in Aerodynamics to speak of Centers of Pressure, and it is very often convenient to employ this term But it would be much better to speak of the position of the resultant vector of forces, a vector being a line representing a force in magnitude and direction. For a flat plate or a cambered wing section, the term center of pressure might answer fairly well, but for a combination of

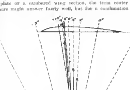


Fig 5 Illustrating Position of Vector of Resultant Forces

wing surfaces as in a biplane, or for any kind of aeroplane, it is very unsatisfactory Thus as in Fig. 5 for certain angles the resultant force passes right outside the wing surface, and to speak of a center of pressure in such a case is meaningless

It is also often stated that the stability of a wing depends on the motion of the center of pressure with reference to the center of gravity The moment about the center of gravity can be more correctly stated as depending on the position and direction of the resultant vector of forces. If current practice leads us to speak of center of pressure, the reader will always bear these considerations in mind

Forces on a Flat Plate Immersed in a Fluid and Normal to the Direction of Motion

Newton first considered the case of a flat plate moving normally to its direction of motion. He stipulated a medium composed of an infinite number of small particles, having no sensible magnitude but possessing mass, and not interconnected in any way. A plate of area A, moving with a velocity

Fig 6 Motion Near a Flat Plate Normal to the Wind

V in a medium of density ρ would meet a quantity of fluid ρAV and impart to this quantity a velocity V per unit of time.

From the fundamental equation in mechanics:

$$\text{Force} = \frac{(\text{mass acted upon}) \times (\text{velocity imparted})}{\text{Time}}$$

we should derive the equation.

$$R = \frac{(\rho AV)}{g} V = \frac{(\rho AV^2)}{g}$$

Similar reasoning from the Principle of Relative Motion would apply were the plate held at rest, and the fluid impinging on it The force as derived from actual experiment is considerably less than this

But Newton's theorem is obviously incorrect, no account being taken of the action at the back of the plate, or of the complicated interaction between the particles, or of the formation of eddies and whirls. The photograph in Fig. 6 gives an idea of the complicated actions which take place These are represented diagramatically in Figs. 7 and 8

From a consideration of Bernoulli's Theorem it will be seen that the pressure in front of the plate will become greater than the statical pressure of the stream At the back of the plate, owing to the considerable velocity of the eddies or whirls, we can say again from a consideration of Bernoulli's

Fig 7

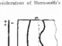


Fig 8

Diagrams Illustrating Fluid Motion and Pressure Distribution on Plates Normal to the Stream

equations—that the pressure will be less than the statical pressure It is to the difference in pressures front and back of the plate that the resistance is due. Fig. 8 represents roughly the distribution of pressure on either side of the plate.

Newton was correct, however, in so far as the resultant force of a plate normal to the wind is proportional to the velocity squared, the area, and the density; and if R denotes the resultant force we can write:

$$R = KAV^2$$

where K is an experimental coefficient

We shall show later that a similar law holds for all cases of bodies producing turbulent flow, and discuss fully the resistance due to such flow.

Forces on Flat Plates Inclined to the Wind

Figs 9 and 10 represent diagrammatically the fluid section in the case of an inclined plate, and the distribution of pressure, which are further illustrated by the photograph (after Riabouchinsky) in Fig. 11.

Just as in the case of the plate normal to the wind, the resultant force will be determined by the difference in pressures of the front and back of the plate, and lift and drag will vary as AV^2, as in the case of all bodies producing turbulent flow, with a different coefficient for each angle of incidence

The minimum resultant force of a plate occurs when it is in the line of the wind. As the angle of incidence increases so does the pressure, until a critical angle of some 40 degrees is reached. After this resultant force slowly diminishes to the value in normal presentation.

At small angles the center of pressure is near the mid position, and gradually moves forward as the angle of incidence increases. That the center of pressure should be forward of the mid position is fairly obvious from the above mentioned photograph. It is in the forward region of the plate that the plate experiences the most abrupt changes of direction, with consequently the greatest variation of pressures. This can be seen also from the diagram of distribution of pressures.

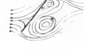


Fig. 9

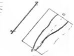


Fig. 10

Diagrams Illustrating Fluid Motion and Pressure Distribution on Inclined Plane.

Numerous efforts have been made to deduce expressions for lift and drag and for the motion of the center of pressure from theoretical considerations. But the only trustworthy values are those directly taken from experimental data obtained by Eiffel and others which will be dealt with later.

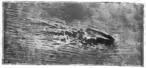


Fig. 11. Motion Near a Flat Plate Inclined to the Wind

It may be stated here to remove a somewhat common misconception, that the resultant pressure on a flat plate is not perpendicular to the plate except for a certain limited range of angles of incidence. At zero degree of incidence the resultant pressure is 90 degrees behind the normal, rapidly approaches the normal at small angles, and shoots past it at 10 degrees.

The Curtiss Wireless Speed Scout

The new Curtiss plane that is shown in the accompanying illustrations is without the propeller and the stream line cowl. In this machine, which offers many interesting features, the wing spread has been cut down to a minimum, the upper wing having a span of 21 feet 10 inches and the lower wing a span of 11 feet 3 inches. The wing section is similar to that of the Eiffel 32, with a thin rear spar.

Besides the four short struts between the upper wing and the fuselage, there are only two interplane struts. These interplane struts are of steel tube construction, with wood spacers to give stream-line form. They are connected to both front and rear spars on both planes. One chassis strut comes immediately under the interplane strut on each side of the wing to take up stresses on landing. The other is carried from the body to the axle.

The machine is designed to carry no bracing wires whatever, the struts acting as either compression or tension members.

On the preliminary tests three bracing wires were used on either side, and a drift wire carried forward to the fuselage.

The net weight of the machine is 805 pounds, with a 100 horse-power OXX 2 motor. The scout was timed by the Curtiss Company over a measured mile, covering it in 30 seconds one way and 31 seconds the other, giving an average speed of 119 miles per hour. When seen in flight, the machine gave the appearance of being under easy control of the pilot, and the landing was a very easy one. It is possible that a slight dihedral of the two planes might increase the lateral stability.

When flown without bracing wires, in accordance with the engineers design, it is predicted that a speed of 125 miles per hour will be attained.

Such a type, if further use confirms its reliability, will mark a considerable development in American construction. Although no provision has been made for gun carrying, this will be possible with slight modification in the design.

The Curtiss Wireless Speed Scout

The Hall-Scott, Type A-7, 90-100 Horse-Power Aeroplane Engine

To meet the demand for a simple and dependable engine for use in training schools, on scout machines and by sportsmen, the Hall-Scott Motor Car Company, Inc., San Francisco, Cal., has designed a new four-cylinder aeroplane engine that is rated at 90 to 100 horse-power. This motor, which is known as Type A-7, is expected by the manufacturer to meet such demand adequately.

One of the advantages claimed for this engine is that it eliminates at least twenty five per cent of the parts necessary for the eight-cylinder motor of the V type. In order to keep the weight down in the regular eight-cylinder engine vital parts, such as crankshafts, crank cases, cylinders, cylinder hold-down studs, connecting rods and other parts, are sometimes not made heavy enough to withstand the hard continuous usage to which the aeroplane motor is necessarily subjected.

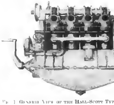


Fig. 1. General View of the Hall-Scott Type A-7 Engine

Although the weight of this motor is restricted to a reasonable figure, vital parts are used that in many cases are interchangeable or embody the same strength as in the larger and more powerful Hall-Scott type A-5 engine. The advantages of having the same strength in the parts of a motor that develops 90 to 100 horse-power as have been found satisfactory in one rated at 150 horse-power are apparent.

Another advantage that is claimed for this four-cylinder engine over the eight-cylinder V-motor is that in dissembling the four-cylinder engine every part is readily accessible, and that it is so simple in construction that any person with automobile engine knowledge is competent to overhaul it. The method of mounting the four cylinder engine is very simple.

The use of side radiators is advocated and can be regularly installed on aeroplanes like the Glenn L. Martin Army tractor, in which the upper portion of the radiators is higher than the upper parts of the cylinders, thus eliminating the necessity of carrying an auxiliary water tank over the engine. However, if the style of aeroplane necessitate locating the radiators so that their top is below the top cylinder line, an auxiliary water tank may be mounted above the motor.

The oil and gasoline consumption of this engine are said

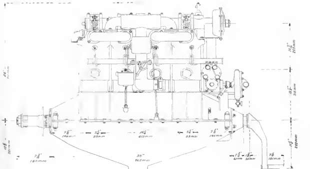


Fig. 2. Side Elevation of the Hall-Scott Type A-7 Engine

to be extremely low for the horse power developed. The following data is reported from the latest Martin "TT" Army tractor equipped with the Hall-Scott type A-7 power plant

500 pounds load 3,400 feet 10 minutes
580 pounds load 2,400 feet 15 minutes
580 pounds load 5,000 feet 30 minutes
580 pounds load 10,400 feet 100 minutes
580 pounds load speed average (average taken from four flights) 70 miles per hour
Consumption gasoline 8 gallons per 1 hour and 15 minutes
Consumption oil 3⁄4 gallon per 1 hour and 45 minutes
Average revolutions per minute of motor 1,370

The following details regarding this engine are obtained from the specifications issued by the manufacturer.

Sizes.—The engine has a bore of 5 inches and a stroke of 7 inches.

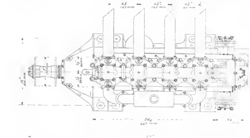


FIG. 3. PLAN OF THE HALL-SCOTT TYPE A-7 ENGINE

Cylinders.—Four cylinders are cast separately from a special mixture of semi-steel, having cylinder head with valve seats integral. Special attention has been given to the design of the water jacket around the valves and head, there being 2 inches of water space above same.

The cylinder is annealed, rough machined, then the inner cylinder wall and valve seats hardened and ground to mirror finish. This adds to the durability of the cylinder and diminishes a great deal of the excess friction. Care is taken in the casting and machining of the cylinders to have the bore and walls concentric. Small ribs are cast between outer and inner walls to assist cooling as well as to transfer stresses direct from the explosion to hold-down bolts which run from steel main bearing caps to top of cylinders.

The cylinders are machined upon the sides so that when assembled on the crank-case with grooved hold-down washers tightened they form a solid block, greatly assisting the rigidity of crank-case.

All cylinders are finished with dark blue baked enamel.

Connecting Rods.—The connecting rods are very light, being of the I-beam type, milled from a solid chrome nickel steel drop forgings. The caps are held on by two ½-inch 20-thread chrome nickel through bolts. The rods are first roughed out, then annealed. Holes are drilled, after which the rods are hardened and holes ground parallel with each other. The piston end is fitted with a gun metal bushing, while the crank-pin end carries two bronze serrated shells, which are tinned and babbitted hot, being broached to harden the babbit. Between the cap and the rod proper are placed laminated shims for adjustment.

Crank-Case and Oil-Sump.—Crank-cases are cast of aluminum alloy, hand scraped and sand blasted inside and out. The lower oil case can be removed without breaking any connections excepting one outside oil pipe union so that the connecting rods and other working parts can readily be inspected. An extremely large strainer and dirt trap is located in the center and lowest point of the case, which is easily removed from the outside without disturbing the oil pump or any working parts.

Carburetion.—A Zenith carburetor is provided. Automatic valves and springs are absent, making the adjustment simple and efficient. This carburetor is not affected by altitude. A Hall-Scott device, covered by patent, allows the oil to be taken direct from the crank-case and run around the carburetor manifold, which assists carburetion as well as reduces crank-case heat.

Starting Crank.—The starting crank is mounted in a compact aluminum housing securely bolted to main crank-case, thus forming an integral part of the motor.

Gears.—All gears, with the exception of the two bronze oil pump gears, are of chrome nickel steel, turned up from extremely light forgings with planed teeth, are then hardened, the bore and faces being ground true. All gears, where possible, are bolted to flanges or made integral with shaft. All gears are enclosed and run in oil bath.

Magnetos.—Two waterproof four cylinder Splitdorf "Dixie" magnetos are provided. Both magneto interruptors are connected to a rock shaft integral with the motor, making outside connections unnecessary. With an independent double magneto system one magneto can break down without interfering with the action of the motor.

Piston Assembly.—The pistons are cast from Lynite. These are extremely light, yet provided with six deep ribs under the arch head, greatly aiding the cooling of the piston as well as strengthening it. The piston pin bosses are located very low in order to keep the heat from the piston head away from the upper end of the connecting rod, as well as to manage them at the point where the piston fits the cylinder best. These pistons are fitted with three rings ¼ inch in width. A large diameter heat treated chrome nickel steel wrist pin is provided assembled in such a way as to assist the oil in the rib between the wrist pin bosses to keep the piston from being distorted from the explosions.

Oiling System.—The oiling system is the high pressure type, oil being forced to the under side of the main bearings with from 5 to 30 pounds pressure. This system is not affected by extreme angles obtained in flying, or by using the motor in tractor or pusher machines.

A large gear pump is located in the lowest point of the oil sump, and being submerged at all times with oil, does away with troublesome stuffing boxes and check valves. The oil is first drawn from the strainer in oil sump to the long jacket around the intake manifold, then forced to the main distributor pipe in crank-case, which leads to all main bearings. A by-pass, located at one end of the distributor pipe, can be regulated to provide any pressure required, the surplus oil being returned to the case.

Independent of this system, a small direct drive, rotary oiler feeds oil to each individual cylinder, being regulated by the speed of the engine. Hand adjusted sight feed allows additional regulation. A feature of this system is the dirt, water and sediment trap, located at the bottom of the oil sump. This can be removed without disturbing or dismantling the oil pump or any oil pipes.

A small oil pressure gauge is provided, which can be run to the aviator's instrument board. This registers the oil pressure and also determines its circulation.

Cooling System.—The cooling of this motor is accomplished by the oil as well as the water. This is done by circulating the oil around a long intake manifold jacket, the carburetion of gasoline cools this regardless of weather conditions. Crank-case heat is therefore kept at a minimum regardless of weather conditions.

The uniform temperature of the cylinders is maintained by the use of ingenious internal outlet pipes, running through the head of each of the six cylinders, rubber hose connections being used so that any one of the cylinders may be removed without disturbing the others. Slots are cut in these pipes so that cold water is drawn directly around the exhaust valves. Extra large water jackets are provided upon the cylinders, 2 inches of water space is left above the valves and cylinder heads. The water is circulated by a large centrifugal pump, insuring ample circulation at all speeds.

Crank-Shaft.—The crank-shaft is of the seven bearing type, being machined from a special heat treated drop forging of nickel steel, first drilled, then roughed out. After this the shaft is straightened, turned down to a grinding size, then ground accurately to size.

The bearing surfaces are of large size, over-size considering general practice in the building of high-speed engines of similar bore and stroke. Steel oil scuppers are pinned and sweated onto the webs of the shaft, which allows of properly oiling the connecting rod bearings. The crank shaft bearings are 2 inches in diameter by 1 15/16 inches long, excepting the rear main bearing, which is 4⅜ inches long, and front main bearing, which is 2 3/16 inches long.

Two thrust bearings are installed on the propeller end of the shaft, one for pull and the other for thrust. The propeller is driven by the crank-shaft flange, which is securely held in place upon the shaft by six keys. These drive an inside propeller flange, the propeller being clamped between them by six through bolts. The flange is fitted to a long taper on crank-shaft. This enables the propeller to be removed without disturbing the bolts.

Timing gears and starting ratchets are bolted to a flange turned integral with shaft.

Cam-Shaft.—The cam-shaft is of the one-piece type, cams, air pump eccentric, and gear flange being integral. It is made from a low carbon specially heat treated nickel forging, is first roughed out and drilled the entire length, the cams are then formed, after which it is case hardened and ground to size. The cam shaft bearings are extra long, made from Parson's White Brass. A small clutch is milled in gear end of shaft to drive the revolution indicator.

The cam-shaft is enclosed in an aluminum housing bolted directly on top of all four cylinders, being driven by a vertical shaft in connection with bevel gears. This shaft, in conjunction with rocker arms, rollers and other working parts, is oiled by forcing the oil into end of shaft, using same as a distributor, allowing the surplus supply to flow back into the crank-case through hollow vertical tube. This supply oils the magneto and pump gears.

Valves.—Extremely large tungsten valves, being one-half the cylinder diameter, are seated in the cylinder heads. Large diameter oil tempered springs held in tool steel cups, locked with a key, are provided. The ports are very large and short, being designed to allow the gases to enter and exhaust with the least possible resistance. These valves are operated by overhead one piece cam-shaft in connection with short chrome nickel rocker arms. These arms have hardened tool steel rollers on cam end, with hardened tool steel adjusting screws opposite. This construction allows accurate valve timing at all speeds with least possible weight.

Air Pump.—A power driven air-pump to maintain air pressure in gasoline storage tank is provided on this engine, driven directly by means of cam formed intergral with cam-shaft. A hand air pump is also provided, so that air pressure may be obtained in the gasoline storage tank before the engine is started.

Accessories.—Eleven special wrenches, two oil cans, two knife switches, eight propeller bolts and nuts, gasoline line dirt trap, cam-shaft auxiliary oil tank and pump, dash oil sight feed, air and oil gauges, hand air-pump, with flexible tubing leads, two block radiators for installation either side of aeroplane fuselage, and laminated walnut propeller, are supplied with each engine.

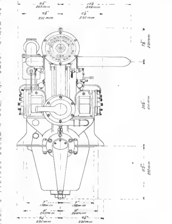


FIG. 4. END ELEVATION OF THE HALL-SCOTT TYPE A-7 ENGINE

Weight.—The weight of this engine, complete, ready for installation in aeroplane, 410 pounds.

Capacity.—This engine will develop 90 to 100 horse-power at a speed not greater than 1,400 revolutions per minute.

Special Fittings.—Revolution indicators, with 8-foot flexible drive shafts, and exhaust manifolds, designed and built to suit requirements of engine installation in different style planes, can be supplied.

Without any startling innovations, the motor seems to be of a simple and reliable type of design, and it will be interesting to watch its employment on the type of machines for which the makers intend it.

It may possibly be more useful on school machines than on high speed scouts—not because of lack of reliability or efficiency of performance, but because of its height.

Book Reviews

MODEL AEROPLANES AND THEIR MOTORS

By George A. Cavanagh

(Moffat Yard & Company Price $1.00 Pp 142)

The author has modestly entitled this volume "a practical book for beginners" It is so thorough and comprehensive and so carefully written as to constitute almost a standard text-book of the subject—this terrifying word, however, belies the clear and simple style which is found throughout.

The author begins with a history of model work. The year 1907 first saw model aeroplaning introduced in America as a sport, under the auspices of the New York Model Aero Club. Sketching the extremely rapid development of the sport since that date, mention is made of the world's record for distance for hand launched models which has been broken by Thomas Hall of Chicago an Illinois Model Aero Club member with a flight of 5,337 feet.

A very useful tendency of latter day practice is to construct model flyers more closely resembling large machines, driven by compressed air, steam and gasoline power plants. Such models, not merely "flying sticks" should serve to throw light on actual construction and cease to be merely interesting toys.

The section dealing with construction is authoritative and thorough. Very clear sketches and full, workmanlike instructions are given for the construction of propellers, wings, frames, and for assembling, which can be safely followed by any model constructor. The hints on launching are likely to save the beginner a good deal of trouble in his early work.

Full information is given both on compressed air motors, such as the Wise, the Schober-Funk three cylinder, the Schober four-cylinder opposed motor and on gasoline motors, such as the Jopson Midget aero gasoline motor. Steam power plants are also described.

A number of world record models are illustrated which will serve as useful examples for the amateur constructor. The Dictionary of Aeronautical terms and the generally sound treatment would also help a reader who wishes to proceed later in a more serious study of the art. From the purely model point of view no better book could be selected by the beginner, or even by the experienced model worker, who wishes to have a handbook as his standby.

AIRCRAFT IN WAR AND PEACE

By William A. Robson

(The Macmillan Company Price $1.00 Pp 171)

Conveying in non technical language a general idea of the conditions of aircraft work in the war, this work also includes the chief directions in which development is being made. The volume tells of war with aircraft, and what the British have accomplished. A chapter is devoted to the Royal Flying Corps and the Royal Naval Air Service. The subjects of scouting in the air, air raiding, the airship vs the aeroplane are carefully treated. Types of aircraft in use are described.

The second part of the volume is devoted to telling how an aviator is trained and to the making of aeroplanes which is described at length. In Part III, the future of civilian and military aeronautics is looked into. The author anticipates that civilian and military flying will inevitably part company because of the different objects to be attained. The separation will take place because of the different designs in military aeroplanes and those constructed for the various civilian uses. He thinks that in the future military machines of nearly all types will be as essentially distinct from civilian aeroplanes as naval ships are from merchantile or pleasure vessels.

Anti-aircraft guns which to-day are considered almost harmless at times and at other times deadly to the extreme may, when fully developed, become as dangerous to aeroplanes, even the armored ones, as the modern siege gun is to a fort.

It is anticipated that there will be a great demand for pleasure aeroplanes when the cost is brought down to be within the means of those who can now afford to buy cheap priced automobiles.

ZEPPELINS AND SUPER-ZEPPELINS

By R. P. Hearne

(John Lane Company Price $1.00 net Pp 155)

This is an excellent volume, very well illustrated. Entirely popular in character, it gives accurate and simple explanations of the main dirigible types, and discusses in elementary form questions of displacement, buoyancy, and variation of buoyancy with height. The limitations of the Zeppelin, its action in warfare, its radius of action and endurance, are fully entered into, and there is a historical survey of its development.

Super-Zeppelins of speeds of over 100 miles an hour, with more gun-firing capacity, are advocated as the best defense against Zeppelins in preference to aeroplanes. The British are brought to task for not developing this type in a way which might be applied to America. The original idea of a rigid ship is attributed to a Frenchman named Spiess, from whom Zeppelin is said to have got his first plans.

AIRCRAFT IN WAR

By J. M. Spaight, LL.D.

(The Macmillan Company Price $2.00 Pp 172)

This book, written before the war, is of course of a prophetic nature as regards the actual bearing of aircraft in warfare on international law. It is, however, the work of a man thoroughly versed in legal matters pertaining to warfare, with a sound knowledge of the construction and military possibilities of aircraft. Such interesting questions are dealt with as the codes proposed by M. Fauchille, by M. Edouard d'Hooghe, president of the International Juridical Committee of Aviation, and others, legislation at the Hague, sovereignty or freedom of the air, belligerent entry of neutral atmosphere, distinguishing marks for aircraft and their crews, seizure, confiscation and destruction of private enemy and neutral aircraft, relation of aerial law to existing conventions, modification of laws of land and maritime war, etc. Written in excellent and simple style, it should be of value to every one interested in the legal aspects of warfare in the air.

Aeronautical Patents

ISSUED JULY 25, 1916

1,192,248. Filed Jan 17 1916. To George M Wann, Oakland, Calif. Improvement on tail construction for aeroplanes.

1,192,470. Filed March 27 1914. To Solomon Lee Van Meter Jr. Lexington, Ky. A parachute life saving device in combination with life buoy for aviators.

1,192,480. Filed August 8 1914. To Solomon Lee Van Meter Jr. Lexington Ky. Improvements on parachute safety device for aviators.

1,192,607. Filed June 25 1910. To Hermann F Cuntz, Hartford Conn. An aeroplane in which a vertically stabilizing plane is substituted for warping or aileron action for lateral control.

1,192,751. Filed May 10 1913. To Robert F Campbell Jr. Waterloo Iowa. Aeroplane provided with an upward concave hull for obtaining longitudinal stability.

ISSUED AUGUST 1, 1916

1,192,954. Filed Nov 29 1907. To William P Thompson, Liverpool, England. An aeroplane with several following wings having upward and downward movement and variable angle of incidence. An ornithopter type.

ISSUED AUGUST 8, 1916

1,194,037. Filed July 3 1914. To Carl Krepp, Dresden, Germany. Propelling device for aeroplanes consisting of two rotating horizontal drums, with interspaced lifting radiating plates.

1,194,126. Filed May 17 1915. To Charles J Blessing, Omaha Neb. An aeroplane with following wings and propellers rotating horizontally along the fuselage as well as vertically in front.

The Wright-Martin Merger

Photo by Edwin Levick

GLENN L. MARTIN

Announcement is made by the Wright Company of its merger with the Glenn L. Martin Company of Los Angeles. This new consolidation will be known as the Wright-Martin Aircraft Corporation, incorporated under the laws of the State of New York, with $5,000,000 seven per cent cumulative convertible preferred stock and 500,000 shares of common stock with no par value. Edward M Hagar, president of the Wright Company, will be president of the new concern. Glenn L. Martin and C S Jennison will be vice-presidents.

Under the arrangement there is acquired the organization headed by Glenn L. Martin, which has in active operation a Los Angeles plant turning out 10 aeroplanes a month. Mr Martin will devote his entire time to the aeroplane department of the new company. The Wright-Martin company takes over the Wright Company, which now owns all the Wright patents, the Simplex Automobile Company and its plant, the stock of the Wright Flying Field, Inc., and that of the General Aeronautic Company of America, Inc., which handles the foreign business of the Wright Company.

Photo by Notman

EDWARD M. HAGAR

The Martin plant at Los Angeles will continue to be operated and a large factory will be erected in the East in the vicinity of New York. The factory of the Wright Company at Dayton will continue its experimental work. The Simplex plant at New Brunswick has been recently enlarged and new buildings are still in course of erection. The shops are filled with the finest machinery produced by modern designers, and the plant is complete and up-to-date. Twenty-two hundred men are at present employed on the new aviation engine and on Simplex cars.

A complete technical laboratory has been operating at New Brunswick for some months, where elaborate tests are conducted on steels and other metals entering into construction of the aero and automobile engines. The Wright flying field is at Mineola, Long Island, where 665 acres of the Hampstead Plains are under lease. The United States Government now occupies fifteen of the twenty aeroplane sheds at the Wright flying field for training of aviators and the testing of machines for Army use.

In view of the demand for a high class reliable aeronautic motor the Wright Company decided to manufacture its own, and to this end it acquired control, some months ago, of the Simplex Automobile Company, long builders of high-grade automobiles embodying a standard of work comparable only with the work necessary in a modern aeronautic motor. It is absolutely essential that such a plant have its own facilities and expensive special machinery to produce the proper quality for a modern motor of the highest type. The company has gone even to the extent of erecting its own pattern shop and foundries for the casting of iron, aluminum and brass. The capacity of the new plant will be over a million dollars a month.

As a part of its plans the Wright Company secured last year the exclusive right to manufacture the Hispano-Suiza aeromotor in this country. The Hispano-Suiza is recognized as one of the best foreign types, the French Government having placed orders for as many as 1,800 of these at one time. It weighs but 363 pounds and is rated at 150 horse-power. Deliveries are about to begin on one order of 450 of these motors from the New Brunswick factory for the French and Russian governments. The first motor has been tested and production in quantities will begin at once.

The Wright Company was originally organized in 1909, with a capital stock of $1,000,000, by Wilbur and Orville Wright, the discoverers of human flight and the first to produce a power-driven aeroplane, six years after their first successful experiments. In 1915 the company was sold to a syndicate headed by William B. Thompson, Harry Payne Whitney, T. Frank Manville and others. The Simplex Automobile Company was also purchased and the capital stock was then increased to $5,000,000. Orville Wright was retained and now continues in a consulting capacity.

In March, 1916, Edward M Hagar, formerly president of the Universal Portland Cement Company of Chicago, a subsidiary of the United States Steel Corporation, was elected president of the Wright Company. The present directors of the Wright Company consist of the following: F. W. Allen, Fred W. Adams, Henry M. Crane, T. L. Chadbourne, Jr., Harvey D. Gibson, David M. Goodrich, Edward M. Hagar, C. S. Jennison, Henry Lockhart, Jr., T. Frank Manville, S. F. Pryor, Henry R. Sulphen and Harry Payne Whitney. Among the principal stockholders are William B. Thompson, A. H. Wiggins, William E. Corey, Percy A. Rockefeller, Ambrose Monell, E. C. Converse, C. H. Sabin, John D. Ryan and Henry R. Carse.

Glenn L. Martin is one of the pioneers of aviation in America. He began in 1909 experimenting with aeroplanes and taught himself to fly, as have so many of the famous flyers of earlier history. In 1910 he was a constructor and through sheer merit, handicapped by lack of proper financial resources, forced his reputation to the top notch. He has a record of having manufactured a comparatively large number of aeroplanes of various types for the United States Government without a single serious accident to pilot or passenger in any of these machines, although continually in use by officers of the Signal Corps.

Orders now on hand by the Martin company are for the United States, Holland and Netherlands East Indian governments. Three types are being produced: a light two-man reconnaissance tractor, adopted for training work in the Signal Corps, a fast two-place tractor carrying a useful load of 960 pounds, with a speed range of 46 to 86 miles an hour, fuel capacity for six hours and a climbing ability of 3,400 feet in ten minutes, and a two-place tractor seaplane, used in the Philippines and the Coast Patrol.

To enable the Wright Company to finance this merger with the Martin company and the Simplex Automobile Company, to complete its own and its subsidiaries' construction work and discharge loans made on account thereof, and to furnish the requisite working capital, about $4,000,000 will be required, $1,800,000 for fixed assets and $2,200,000 for working capital.

Photo by Marceau
GODFREY L. CABOT
President Aero Club of New England

Godfrey Lowell Cabot, president of the Aero Club of New England, was born in 1861 at Boston, Mass. His parents were Dr. Samuel Cabot and Hannah Lowell Cabot. He was educated at the Brimmer School, Boston Latin School, John Hopkinson School, the Massachusetts Institute of Technology and Harvard University, from which he graduated with honors "Magnum cum laude" in chemistry in 1882. After working one year with his brother, Samuel Cabot, mostly occupied with original experiments on natural gas, he went abroad for sixteen months and studied chemistry under the famous chemists, George Lunge and Victor Meyer, and geology under Professor Heim at Zürich, Switzerland.

Later, while in partnership with his brother Samuel, he engaged in the manufacture of gas regulators, and subsequently bought from him in the fall of 1887 his carbon black interests in Pennsylvania. From that time until now he has engaged continuously in the production, distribution and sale of natural gas, and in the sale of carbon black on a steadily increasing scale.

For over ten years he has been the largest individual manufacturer of this commodity. In 1907 the village of Cabot, Pa., was named after him. From 1899 to 1908 there was erected at Grantsville, W. Va., the largest carbon black factory in the world, and he has now seven factories producing this material.

Mr. Cabot has traveled widely, having visited nearly every country in Europe, and he has made special trips to Asia, Central America and the West Indies.

For many years he has had an academic interest in aeronautics, and about a year ago, becoming strongly impressed with the danger to which this country was needlessly subjected by unpreparedness, felt that, as a citizen, he ought to be able to contribute more to the defense of the country by cultivating and promoting military flying than in any other way. Last November he was elected president of the Aero Club of New England. His eldest son, James, is now learning to fly.

The Pan-American Aeronautic Exposition

The Aero Club of America has announced that a Pan American Aeronautic Exposition will be held in January, 1917, in which the American Society of Aeronautic Engineers and the Pan American Aeronautic Federation will co-operate.

The time seems ripe for the manufacturers of aeronautical products to show the great progress they have made recently and the scope of the American industry. It is intended to make the exposition comparable to the automobile shows in the interest of the exhibits.

Aeroplanes, motors, accessories, whether intended for military, sporting or sporting purposes, will be shown, and should attract all those interested in aeronautics as well as make a lasting impression on the general public. It is intended to give the Exposition a Pan American character by inviting delegations from all American countries. As the Pan-American Trophy is to be competed for at Rio de Janeiro in July, 1917, it is believed that the Exposition will stimulate an interest in the event for which the Aero Club of America has offered a $10,000 trophy.

Howard E. Coffin is chairman of the large committee which has charge of organizing the Exposition.

The Aero Club of New England

A. R. Shrigley, secretary of the Aero Club of New England, has forwarded to the clerk of the Massachusetts House of Representatives the following resolution, adopted by the Board of Directors of that club:

WHEREAS, Many able and efficient aviators have been injured in a series of flights in so-called stunt flying and other forms of trick flying; and

WHEREAS, The cost of efficient aviators are greatly needed by the army and navy of the United States and by the militia of the several states for the defense of the nation and of the state; be it

RESOLVED, That the General and Special Court of the Commonwealth of Massachusetts be and is hereby requested to enact a statute prohibiting looping the loop, perpendicular diving and any other forms of trick flying at any exhibition, fair or other public place, and to impose fine or imprisonment or both upon any person or persons giving or offering to give money, prize or gratuity for such trick flying; and such further provisions as to the General Court may seem proper in order to accomplish the purpose desired.

The New York Flying Yacht Club Plans Luncheon

The New York Flying Yacht Club is planning a luncheon to be held August 31. Many noted guests have been invited and plans are being made for 1,000 covers. Rear-Admiral Peary expects to fly to the luncheon from Governor's Island. In connection with the flying demonstration there will be a test of mail carrying from one branch post office to another.

Physiological Tests for National Guard and Naval Militia Fliers

The candidates for aerial service in the National Guard and the Naval Militia, before receiving their military and naval licenses are required to submit to a special rigorous physical examination to determine their fitness for such duty. The essential features of this test are as follows:

The visual acuity without glasses should be normal. Any error of refraction requiring correction by glasses or any other cause diminishing acuity of vision below normal will be a cause for rejection. The candidate's ability to estimate distances will be determined. Color blindness for red, green or violet is a cause for rejection. If the candidate wears glasses, so state, and give the necessity therefor.

The acuity of hearing should be carefully tested and the ears carefully examined with the aid of the speculum and mirror. Any diminution of the acuity of hearing below normal will be cause for rejection. Any disease whatever of the middle ear, either acute or chronic, or a former acute condition, will be a cause for rejection. Any disease of the internal ear or of the auditory nerve will be a cause for rejection.

The following tests for equilibrium to detect otherwise obscure diseased condition of the internal ear should be made: (a) Have the candidate stand with knees, heels and toes touching, (b) have the candidate walk forward, backward and in a circle, (c) have the candidate hop around the room.

All these tests should be made with the eyes open, and then closed; the third test on both feet and then on one foot, hopping forward and backward, the candidate trying to hop or walk in a straight line. Any deviation to the right or left from the straight line or from the arc of the circle should be noted. Any persistent deviation either to the right or left is evidence of a diseased condition of the internal ear, and nystagmus is frequently associated with such condition. These symptoms should, therefore, be regarded as causes for rejection.

The organs of respiration and the circulatory system should be carefully examined. Any diseased condition of the circulatory system, either of the heart or arterial system is a cause for rejection. Any disease of the nervous system is a cause for rejection.

The freedom of the movements of the limbs should be especially carefully tested.

Any candidate whose history may show that he is afflicted with chronic digestive disturbances, chronic constipation or indigestion, or intestinal disorders tending to produce dizziness, headache, or to impair his vision, and any candidate whose condition shows that he is inclined to any excess that may disturb his mental balance, or to alcoholism, should be rejected.

Any marked departure from normal blood pressure will be considered a cause for rejection.

Army and Navy Officers on Aviation Duty

The following list gives the rank of officers on aviation duty in the United States Army, with their present location:

Lieut.-Col. Geo. O. Squier, in charge of the Aviation Section, Washington; Major James B. Mitchell, Assistant, Washington; Col. Wm. A. Glassford, C. O., S. C. A. S., San Diego; Capt. Clarence C. Culver, detailed in connection with radio, San Diego; Capt. Herbert N. Boyden, Q. M. (retired), San Diego; Capt. Roy W. Bryan, Medical Corps, San Diego; Capt. Goodier, (retired), Washington.

JUNIOR MILITARY AVIATORS:—Capt. Thos. DeW. Milling, Washington; 1st Lieut. Jos. E. Carberry, Mineola; Capt. T. F. Dodd, Columbus; 1st Lieut. C. G. Chapman, Columbus; 1st Lieut. H. K. Dargue, San Diego; Capt. B. D. Foulois, Columbus; Capt. F. J. Morrow, Chicago; 1st Lieut. B. Q. Jones, San Diego; 1st Lieut. D. B. Netherwood, Manila; 1st Lieut. T. S. Bowen, Columbus; Capt. W. L. Patterson, Manila; Capt. Clark, Washington; Capt. R. G. Y. Willis, Columbus; 1st Lieut. W. G. Kilner, Columbus; 1st Lieut. S. W. FitzGerald, Manila.

1st Lieut. L. MacDill, Manila; 1st Lieut. A. R. Christie, Columbus; 1st Lieut. E. S. Gorrell, Columbus; 1st Lieut. H. W. Harms, Washington; 1st Lieut. I. A. Rader, Columbus; 1st Lieut. B. Gantz, San Diego; 1st Lieut. E. L. Canady, Manila.

Capt. T. P. Lahm, San Diego; J. F. Curry, Columbus; 1st Lieut. R. Royce, Columbus; 1st Lieut. R. S. Brown, Columbus; Capt. H. H. Arnold, San Diego; 1st Lieut. B. M. Atkinson, Columbus; 1st Lieut. H. S. Martin, Columbus; 1st Lieut. J. B. Brooks, Columbus; 1st Lieut. C. Spatz, Columbus.

AVIATION STUDENTS AT SAN DIEGO:—2nd Lieut. S. H. Wheeler, 25th Infantry; 2nd Lieut. G. H. Brett, 2nd Cavalry; 2nd Lieut. H. C. Davidson, 27th Infantry; 2nd Lieut. C. W. Russell, 8th Infantry; 2nd Lieut. G. E. A. Reinburg, 9th Cavalry; 2nd Lieut. M. F. Y. Harmon, Jr., 27th Infantry; 2nd Lieut. J. C. McDonnell, 11th Cavalry; 2nd Lieut. L. G. Heffernan, 7th Cavalry; 2nd Lieut. J. W. Butts, 3rd Cavalry; 2nd Lieut. J. C. P. Bartholf, 15th Infantry; 2nd Lieut. M. Kirby, 3rd Cavalry; 2nd Lieut. W. A. Robertson, 11th Cavalry; 2nd Lieut. D. Johnson, 19th Infantry; 2nd Lieut. R. B. Barnitz, 14th Cavalry; 2nd Lieut. I. D. von Holtzendorff, 2nd Field Artillery; 2nd Lieut. J. C. Walker, 12th Infantry; 2nd Lieut. M. F. Scanlon, 19th Infantry.

1st Lieut. Dunsworth, C. A. C.; 2nd Lieut. P. L. Ferron, C. A. C.; 2nd Lieut. G. E. Lovell, 7th Cavalry; 2nd Lieut. J. F. Byrom, 19th Infantry; 2nd Lieut. B. G. Weir, 4th Infantry; 2nd Lieut. B. W. Mills, 9th Infantry; 2nd Lieut. F. L. Nadeu, 1st Cavalry; 2nd Lieut. W. W. Wynne, 12th Cavalry; 2nd Lieut. C. W. Howard, 4th Field Artillery; 2nd Lieut. J. T. McNarney, 21st Infantry; 2nd Lieut. R. P. Cousins, 6th Cavalry; 2nd Lieut. T. J. Hanley, Jr., 23rd Infantry; 2nd Lieut. H. Pitsiter, Jr., 24th Infantry.

NAVY AND MARINE CORPS OFFICERS ON AVIATION DUTY

The following list gives the names, ranks of officers of the Navy and Marine Corps performing aeronautic duty at the Pensacola Aeronautic Station:

Lieut.-Comdr. H. C. Mustin, U. S. N.; Lieut.-Comdr. F. R. McCrary, U. S. N.; Lieut. K. Whiting, U. S. N.; Lieut. Junior Grade, G. C. Dichman, U. S. N.; Lieut. Junior Grade, W. W. Corry, U. S. N.; Lieut. Junior Grade, R. T. Young, U. S. N.; Lieut. Junior Grade, E. W. Spencer, U. S. N.; Lieut. Junior Grade, G. B. Strickland, U. S. N.; Lieut. Junior Grade, E. O. McDonnell, U. S. N.; Lieut. Junior Grade, G. S. Gillespie, U. S. N.; Lieut. Junior Grade, M. A. Mitscher, U. S. N.; Lieut. R. W. Cabaniss, U. S. N.; Lieut. Junior Grade, P. J. Peyton, U. S. N.; Lieut. Junior Grade, H. B. Cecil, U. S. N.; Lieut. Junior Grade, V. C. Griffin, U. S. N.; Lieut. Junior Grade, N. B. Chase, U. S. N.; Lieut. Junior Grade, E. H. McKitterick, U. S. N.; Ensign B. G. Leighton, U. S. N.; Ensign C. T. Hull, U. S. N.; Ensign W. Masek, U. S. N.; Ensign R. D. Kirkpatrick, U. S. N.; Lieut. Junior Grade, C. P. Mason, U. S. N.; Lieut. Junior Grade, L. L. Babbitt, U. S. N.; 1st Lieut. F. T. Evans, U. S. M. C.; 1st Lieut. R. S. Geiger, U. S. M. C.

Other officers of the Navy and the Marine Corps, with their ranks and place of duty, are as follows:

Lieut. J. H. Towers, U. S. N., Naval Intelligence Office; Lieut. R. C. Reed, U. S. N., U. S. S. *North Carolina*; Lieut. E. E. Johnson, U. S. N., U. S. S. *North Carolina*; Lieut. W. G. Child, U. S. N., Bureau Steam Engineering; Lieut. L. H. Maxfield, U. S. N., U. S. S. *North Carolina*; Lieut. Junior Grade, P. N. Bellinger, U. S. N., U. S. S. *North Carolina*; Lieut. Junior Grade, C. K. Bronson, U. S. N., Navy Department, Washington; Lieut. Junior Grade, W. Capehart, U. S. N., care of District Inspector of Engineering Material, Custom House, Boston; Lieut. Junior Grade, G. de C. Chevalier, U. S. S. *North Carolina*; Lieut. Junior Grade, G. D. Murray, care of District Inspector Engineering Material, Custom House, Boston; First Lieut. H. G. Bartlett, U. S. S. *North Carolina*; Lieut. Junior Grade, J. C. Monfort, Aeromotor Testing Laboratory, Navy Yard, Washington; Lieut. Junior Grade, H. W. Scofield, care of Curtiss Aeroplane Co., Buffalo; Naval Constructor H. C. Richardson, Navy Yard, Washington; First Lieut. A. A. Cunningham, U. S. M. C., Army Aviation School, San Diego; First Lieut. B. L. Smith, U. S. M. C., Assistant Naval Attache, Paris, France; Second Lieut. Wm. M. McIlvain, U. S. M. C., Army Aviation School, San Diego.

The following officers, not now performing aeronautic duty, are qualified as naval aviators:

Lieut. T. G. Ellyson, U. S. N., Naval Academy, Annapolis; Lieut. John Rodgers, U. S. N., U. S. S. *Columbia*; Lieut. Junior Grade, V. D. Herbster, U. S. S. *Utah*.

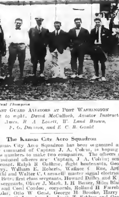


Photo by Paul Thompson

COAST GUARD AVIATORS AT PORT WASHINGTON

From left to right, David McCulloch, Aviator Instructor; James. R. A. Lovell, W. Land Brown, F. G. Dawson, and E. C. B. Gould

The Kansas City Aero Squadron

The Kansas City Aero Squadron has been organized and, under the command of Captain J. A. Colvin, is hoping to enlarge its numbers to make two companies. The officers and non-commissioned officers are: Captain, J. A. Colvin; senior first lieutenant, Ralph R. Guthrie; flight lieutenants, George Quisenberry, William E. Roberts, Wallace C. Rue, Arthur Schritchfield and Walter C. Carswell; master signal electrician, Harry D. Betz; first class sergeants, Howard Dailey and K. M. Blossom; sergeants, Oliver J. Mark, I. H. Beiser, Miles Blaine, H. Davis and Cecil Condon; corporals, Rolland H. Fairchild, George Adair, Otto W. Geist, George H. Brooke, Harry P. Stark, George C. Launder, Jr., Jacob T. Schless and George Meriwether.

The Army's Flying Field at Chicago

Captain Joseph C. Morrow, Jr., now on temporary duty at the War Department in the office of the chief signal officer of the army, will shortly proceed to Chicago for duty in charge of the Chicago school. He will be on the staff of the commanding general of the Central Department. The War Department has no intention of interfering in any way with private flying schools, but on the contrary will reimburse a graduate of such schools who presents himself for service in the army, if he qualifies, the amount of his expenditure for tuition.

SHOOTS SHARKS FROM FLYING BOAT

Photo by Philadelphia Ledger

Beryl Kendrick of Atlantic City, N. J. turned his attention from passenger carrying long enough to have some rare sport in hunting sharks from his flying boat. With a good shot as passenger, he flew near the surface and killed several. The flying boat has a great advantage over the motor boat in work of this kind as the latter scares the fish away.

IT IS REPORTED THAT—

HERBERT PULITZER of New York, Kenneth Merrick of Brookline, Mass., Samuel P. Mandell of Hamilton and Arthur Richmond of Boston are taking a month's training at the Thomas Brothers Aviation School, under the Harvard Undergraduates' Training Fund. Three other Harvard undergraduates, Thomas T. Hooper of Newburyport, Earl H. Bean of Melrose and George C. Whiting of Hingham, are at the Wright Aviation School at Mineola, L. I.

ART SMITH, who was injured in Japan, has returned and hopes soon to resume flying.

ARTHUR E. NELSON and LESTER RENEGAR, two boys of Peoria, have completed an aeroplane of their own construction. They have been at work on the plane for several years. It is equipped with an Emerson motor.

JOHN McCUTCHEON of Chicago, the cartoonist, has enlisted in the First Squadron, U. S. Central Aviation Reserve. Mr. McCutcheon has been an aero enthusiast for a number of years and had a particularly interesting experience in flying in Salonika.

HARRY PAYNE WHITNEY is expending much of his time this summer in flying in his Burgess-Dunn hydroaeroplane. Frank Coffyn, the aviator, who is in charge of the machine for Mr. Whitney has been flying it regularly.

HOWARD S. BORDEN, the well-known sportsman, has added aviation to his other activities. He has his Burgess-Dunn near Atlantic Highlands, and makes flights whenever he can. Mr. Borden is the head of M. C. D. Borden and Sons, a large drygoods firm in New York.

COLONEL GEORGE S. FOSTER, Chairman of the Aviation Committee of the Press Club of Chicago, has been selected Flight Commander of the Illinois Training School of Aeronautical Reserve Service.

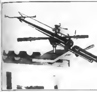
EDWARD FOOTE HINCKLE of Cincinnati has been accepted by the French authorities as a pilot in the American Aeroplane Escadrille. This makes a total of seventy Americans engaged in the French service.

SETH LOW, 2D, Captain of the Yale Varsity crew, has joined the other students, who are flying at Governor's Island in New York harbor.

MISS LYRA BROWN NICKERSON, who has contributed $7,500 toward the purchasing of an aeroplane for Rhode Island, has made several flights with Robert W. Wright over Narragansett Bay in the Sturtevant seaplane that belongs to the detachment.

The PACIFIC AERO PRODUCTS COMPANY has been organized by W. E. Boeing of Seattle, who has been interested in aviation for a number of years. He has established an aviation school under the direction of W. K. Martin. T. Wong, recent graduate of the Massachusetts Institute of Technology in the aeronautical course, is with the company in an engineering capacity.

The CALIFORNIA AEROPLANE AND MOTOR COMPANY has been incorporated and will take over the assets and ownership of the Andermat Company of Sunnyvale, Cal. The headquarters of the new company for the present are at 120 Broadway, New York, at the offices of C. K. Sanborn.



THE DAVIS GUN SHOWING BREECH OPEN

The G. A. AERONAUTIC COMPANY, INC., which has been formed to construct aeroplanes and dirigibles, has been incorporated. The office of the company is 38 North Twelfth Street, Newark, N. J., and the incorporators are J. F. Rogers, S. W. Mower and C. H. Bassford.

The STANDARD AEROPLANE COMPANY is enlarging its plant to enable it to construct and deliver to the Army the twelve tractor biplanes which were recently ordered for use on the Mexican border. The president of the company is H. B. Mingle, a well-known New York lawyer. Charles Day is chief engineer and designer.

The ATWATER AERONAUTIC COMPANY of Williamsport, Pa., has sold several aeroplanes designed by Harry N. Atwood to sportsmen in Williamsport and one to the Pennsylvania National Guard.

The GENERAL AEROPLANE COMPANY of Detroit, Mich., has secured W. L. Bonney, one of the best known aviators in the country, as instructor in its aviation school, which has its headquarters at the old Detroit Motor Boat Club.

Trial Shots from a Large Bore Aeroplane Gun

A large bore aeroplane gun, said to be the largest fired from an aeroplane in America, was recently tried out on the field of the Curtiss Company at Buffalo, N. Y. The gun, which is of the non-recoil aeroplane type built by the General Ordnance Company of Derby, Conn., was mounted on one of the Curtiss J-N twin tractors. The machine was piloted by Aviator Carlstrom and F. B. Towle of the ordnance company acted as gunner. In this test it is said that the machine ascended to the

Photo by J. E. Leaman

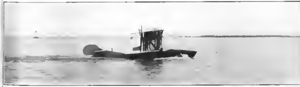
THE DAVIS NON-RECOIL GUN

hight of 4,000 feet, and that while flying at a high speed three successive well-aimed shots were fired. While the report of the gun could be heard for miles around, the pilot and gunner claim that so far as recoil or motion was concerned they would not have known that the gun had been discharged.

Students at the Eastern Aeroplane Company's School

The following students are learning to fly at the school of the Eastern Aeroplane Company at Sheepshead Bay, Long Island: Edward W. Johnson, Alfred Kackosch, Michael J. Latzeck, Anthony Paleo, Christopher Dalar, Carl Fredricksen, Michael Zick, John R. Hogan, Rudolph A. Trosht, Jad D. Mitchell, John T. Keeley, Stewart W. Reid and M. C. Trowbridge.

They are taught first on a monoplane and later on a high-powered tractor biplane. Edward F. Marshont is the designer and constructor of the company, and F. C. Hild assisted by Wm. Diehle are instructors.



VERVILLE FLYING BOAT.

The Verville Flying Boat is built by the General Aeroplane Company of Detroit, Mich. One may be seen flying nearly every day over Lake St. Clair. This type bids fair to prove very popular with the sportsmen of the Great Lakes.

THE WILLIAMS PRINTING COMPANY, NEW YORK